Iron and Steel Engineer

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T. B. LITTLE, EDITOR

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Reading from left to right can be seen W. E. Miller, Elec. & Mech. Supt., Bethlehem Steel Company, Johnstown, Pa.; L. F. Coffin, Supt. Mechanical Dept., Bethlehem Steel Co., Sparrows Point, Md.; O. R. Jones, Elec. Supt., Sharon Steel Hoop Co., Lowellville, Ohio.; J. D. Donovan, Elec. & Mech. Supt., Republic Steel Corp., Massillon, Ohio; W. H. Burr, Elec. & Mech. Supt., Lukens Steel Company, Coatesville, Pa.; J. Farrington, Elec. Supt., Wheeling Steel Corp., Steubenville, Ohio, and G. R. Carroll, Elec. Supt., Jones & Laughlin Steel Corp., Aliquippa, Pa., who were among the many steel mill engineers attending the conference.

SPRING ENGINEERING CONFERENCE ATTRACTS LARGE GATHERING

From every steel center in the United States came 1,000 steel mill officials and engineers to attend the annual spring engineering conference of the Association which was held in Youngstown, Ohio, April 24 and 25. This yearly meeting sponsored by the combustion engineering division of the society drew the largest assemblage that has ever attended this annual assembly.

The success of this meeting was due largely to the efficient functioning of the various committees set up to promote this gathering. Under the direction of the general chairman, J. L. Miller, Assistant Chief Engineer, Carnegie Steel Company, Youngstown, Ohio, and F. E. Leahy, General Secretary, and Fuel Engineer, Youngstown Sheet and Tube Company, Youngstown, Ohio, each committee proceeded to handle its respective duties in a manner which presaged success long before the opening of the conference.

The conference was opened on Wednesday evening, 7:30 o'clock, by Walter H. Burr, who, as the President of the society, welcomed the members of the Association. From that point on the meetings were presided over by the various chairmen and secretaries appointed for the different sessions.

The technical program was initiated by various papers and discussions on the subject of Maintenance of Roll Neck Bearings. These were led by H. D. Robb, Timken Roller Bearing Company; G. Palmgren, SKF Industries, Inc.; A. Frauenthal, Bantam Ball Bearing Company; J. Hitchcock, Morgan Construction Company, and S. F. Keener, Salem Engineering Company.

Inaugurating the Thursday morning session was a paper on the subject of Selection of Electrical Equipment For Direct Current Power Supply in Rolling Mills by C. Lynn of the Westinghouse Electric and Manufacturing Company. Following this

Walter de Fries, Combustion Engineer, delivered a paper on the Metallurgical and Thermo-Dynamic Calculations as Applied to Heating Furnaces. The last paper of the morning was one written by G. R. McDermott, Surface Combustion Corporation, on the subject of Soaking Pits.

Beginning the Thursday afternoon session, a discussion on wide strip mills was led by very prominent steel mill engineers actively engaged in this pertinent phase of the rolling mill industry. Following this R. S. Bower, Open Hearth Superintendent, Corrigan-McKinney Steel Company, presented a paper on the Developments in Design and Operation of Open Hearth Furnaces. The conference was concluded with a paper on Natural Gas in the Steel Industry by Karl Emmerling of the East Ohio Gas Company.

HENRY ROEMER, President Sharon Steel Hoop Company, Sharon, Pa., who acted as official host to the conference.

Supplementing the efforts of the membership in promoting this successful conference was the co-operation of the various steel mill officials of the Youngstown district who were not only willing but anxious to do everything possible to assure the society of an outstanding meeting in their city.

Starting with the June issue of the Iron and Steel Engineer, the papers and discussion presented at the conference will be published in this and succeeding issues. The first papers selected for publication will be those on the maintenance of roll neck bearings, and the use of natural gas in the steel industry.

Other prominent members of the association who gathered to hear the various papers were, reading from left to right: W. H. Burr, Elec. & Mech. Supt., Lukens Steel Company, Coatesville, Pa.; R. S. Shoemaker, Supt. of Rolling Mills, American Rolling Mill Co., Middletown, Ohio; F. C. Swartz, Open Hearth Supt., Carnegie Steel Company, Youngstown, Ohio; H. G. R. Bennett, Asst. Gen. Supt., Carnegie Steel Company, Duquesne, Pa.; J. L. Miller, Asst. Chief Engineer, Carnegie Steel Company, Youngstown, Ohio; F. E. Flynn, Asst. Dist. Mgr., Republic Steel Corp., Warren, Ohio; and A. W. Steed, Supt. of Maintenance, American Rolling Mill Company, Middletown, Ohio.

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PROGRESS OF ELECTRIC WELDING IN THE STEEL INDUSTRY

By H. J. BOWLES
Welding Supervisor, Bethlehem Steel Company, Bethlehem, Pa.

Paper presented before the Philadelphia Section of the A. I. & S. E. E., March 2, 1935.

Progress throughout history has always been the result of periods of revival of national interest in learning with research and investigation as the motivating force behind any advance. The history of welding in the steel industry has been one of progress following experiment and research; first in the perfection of practice and technique, and later, by study of the metallurgy of metals brought into intimate contact by means of welding. It is through this avenue of inquiry and interest that lasting progress in the art of welding will be realized.

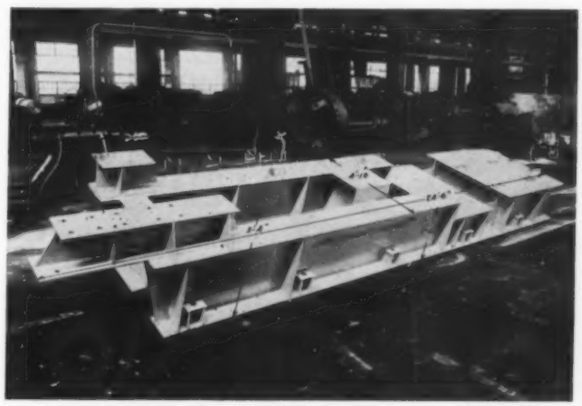
Like many other inventions, the industrial world has been slow in making practical application of the welding processes. In fact, it has only been used during the past 12 to 15 years for repairing damaged or defective materials, and it has been even more recently that arc welding has been applied to regular manufacturing processes. We feel that as the successful use of welded equipment becomes more wide spread, the present objections to its use will be overcome and its field of usefulness will continue to grow much more rapidly than has been the case during the past decade.

This discussion will stress primarily, types of welding employed at the Bethlehem Plant of Bethlehem Steel Company, rather than actual details of practice with which most of you are quite familiar. Also distributed through the paper are illustrations showing jobs fabricated by the welding process.

Gas tight collecting main for coke ovens.

The instruction and qualification of men comes first because we firmly believe that the success or failure of welding depends primarily upon the welders themselves.

The appreciation of this important factor, together with the increasing difficulty of securing satisfactorily trained welders, convinced us that the only logical step was the formation of a welding training course for our men. Accordingly, in 1930, the present welding school was started. Since that time we have trained about 90 welders who now constitute the backbone of our welding personnel today. The candidates for this school are young men mechanically inclined, preferably with a high school education who are selected from the various plant operating and maintenance departments. These men must attend welding school four evenings per week for two hours per session on their own time. The length of the training period varies with the aptitude of the pupil. He must finally pass the tests required by all welders working in the plant before he can work on regular jobs. This training period averages four to five months in cases of good material.



View illustrating a machinery base

By training our own men, we are able to maintain a uniform technique and better workmanship. With properly trained operators we are qualified to handle the wide variety of work that arises in a steel plant, which manufactures steel shapes, alloy bars, simple and alloy forgings, brass, iron and steel castings, as well as machinery of many kinds not only for its own use, but for other industries.

We have a welding department whose function is to co-operate in the proper application of welding to our specific problems of production as well as repair. This gives us a close supervision of the welding being done in the various departments throughout the plant.

We have a welding supervisor, reporting directly to the superintendent of the service division, whose duties are to outline methods of procedure for special production and maintenance jobs and also see that the proper technique and electrodes are used. Arc welding in all the various departments is under his supervision. In order to insure quality work,

each operator is required to make periodical tests. We feel that when welders have proven themselves capable of doing first class work, they should be kept up to grade by frequent tests and constant inspection of their work, because the success of welding depends, to a very great extent, not only on the ability of the welder to do good work, but also on his continuous desire to do nothing but good safe welding.

By applying welding to the construction and repair of a wide variety of plant equipment we have been able to materially cut the cost of plant maintenance. This is being done with an organization of 80 to 90 welders who are working more time than most other crafts in our plant.

Jig and fixtures of fabricated and welded construction is standard practice in our plant. This eliminates patterns, castings and a lot of extra machining, giving a lighter, stronger, and a cheaper fixture, with above all, a minimum delay from blueprint to use.

Many machine parts formerly appearing as castings are now being fabricated from structural shapes and plates. This not only eliminates pattern and foundry cost, but also makes a lighter and stronger job.

Maintenance welding reduces the number of spare parts necessary for safe operation in that worn and broken parts can be quickly repaired or replaced without serious delay especially on obsolete parts when it would be necessary to make a pattern. It is standard practice in our plant to repair all worn or broken machine parts if by so doing we can show a saving.

An enormous saving has been realized by reclaiming worn coupling boxes, spindles, pug mill blades, bucket lips, switch points, manganese crossings, shafts, motor casings, gas engine cylinders and valve seats, roller line rolls, crusher jaws, charging machine peels, crane parts, and many others too numerous to mention.

The successful repair of broken parts depends, to a very great extent, on the preparation of the job before applying the weld. All cracks should be thoroughly chipped or burned out and if there is any doubt that the crack is still present, the section should be acid etched because if a weld is applied over a crack, the part repaired will fail again since the crack will tend to grow back through the deposited metal.

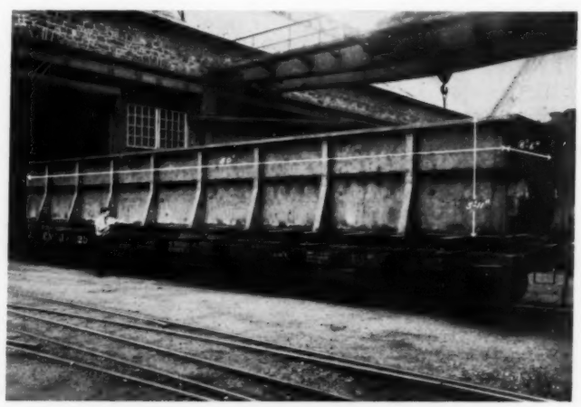
In walking over the plant it is easy to distinguish new installations and changes because they are practically all welded, such as pickling tanks, hot metal ladles, slag ladles, quencher cars, railroad cars, annealing boxes, blast furnace skip buckets, locomotive tenders, gas lines, steam lines, tanks, motor bases, gears, brake wheels, pulleys, gear covers, housings, roller lines, high tension towers, cranes, furnaces, stocks, crane runways, and many other similar jobs.

One of the most important steps to be taken in the development of welding is to introduce sound engineering designs in the equipment to be produced or repaired. This means that the existing engineering personnel must become welded-minded if they are to think and design in terms of welding rather than the old conventional methods of fabrication and construction.

Five or six years ago 200 amp., 25 volt welding generators were considered ample to handle the work then produced with bare or flux coated electrodes. At that time very little was known about heavy covered rods in the United States and we were content with getting a mechanically sound weld without taking into consideration the metallurgy of the deposited metal.

With the introduction of covered electrodes, the picture has been changed, and today it is possible to get a metallurgically high class weld deposit. A few years ago, with the old bare wire method, welding speed was about two pounds per hour, but now it is possible to more than triple the rate of deposition without sacrificing quality.

Since the introduction of covered arc electrodes new fields have been opened to the welding industry particularly alloy and high pressure welding. In this field we find the very highest class of welding which necessarily requires close supervision and metallurgical control.



All-welded rubber lined acid pickling tank.

Greater speeds seem to be the slogan of the welding industry and each year the electrical manufacturers are required to make heavier machines until today 400 to 600 amp. generators are standard equipment in a great many shops; 450 to 500 amp. is about the limit an operator can handle manually. Above this range, even with automatic equipment, welding often isn't satisfactory with D.C. generators due to magnetic interference.

Today the trend seems to be towards A.C. power especially in welding of heavy seams and joints of pressure vessels. With this equipment currents up to 1000 amperes are possible without sacrificing a uniform high class weld. This is partially due to the absence of magnetic interference which is always present in D.C. welding. The absence of magnetic blow also enables fillet welds of the highest quality to be made in some locations where a D.C. arc would be deflected from the point. This is a decided advantage in production shops where shapes are fabricated into machine parts.

Only the more or less general forms of welding procedure which are accepted as standard practice in many industries has been covered up to this point. Another most interesting aspect of welding in our plant is intimately connected with the many various alloys which we produce and it is in this field that the need for a carefully directed research and metal-

lurgical study is absolutely essential to successfully accomplish the desired results.

The manufacturers of welding electrodes have been encouraging heavier rods and higher currents. This is all right on low carbon steels, but when we get into the alloy field, high speeds and heavy currents must be approached with great care since either or both may be detrimental to a good weld.

With the introduction of high strength alloy steels, new problems have confronted the welding industry and each problem must be considered individually as no two alloys react in the same manner under the arc. Each steel requires a special technique and usually a special electrode.

For example, as the carbon content and the proportions of the alloying elements increase, steels generally develop increased air hardening tendencies,

All-welded open hearth 100 ton ladle.

and to avoid cracking, it is necessary to pre-heat the job before applying the arc and stress relieving by heat treatment after the welding is done.

In the welding of special steels, electrodes with heavy covering are preferred and in most cases are essential due to the reaction of the elements when exposed to the atmosphere while the metal is passing through the arc.

The electrode manufacturers today are in a position to furnish rods covering a wide range of alloy contents, which have good welding characteristics, and which will deposit good sound ductile metal. Most alloy rods are designed for down hand welding and until universal rods are available the welding of alloy steels will be limited.

Broadening of the application of welded alloy steel structures is practically certain, due to their corrosion-resisting properties and high strength, thus permitting a lighter construction.

Many special steels may be satisfactorily welded but electrodes and methods must be selected with great care. In most cases it is essential that all welds be made in a series of small beads with light rods and low currents.

Medium manganese steel (1.40 to 1.60 mn) welding also requires a certain amount of care in making the deposit. All welds should be made in a series of small beads without overheating the parent metal. Making welds in one pass, by using heavy electrodes and high current, should be avoided since the weld will tend to crack immediately after it is completed.

Stainless steel welding is comparatively simple, providing a few fundamental principles be taken into consideration. Carbon content of the metal must be known and taken into consideration. High carbon stainless steel must be annealed following welding, otherwise corrosion-resisting properties and ductility will be lacking. Since stainless steel has a high co-efficient of expansion this also must be taken into consideration. The actual welding operation does not present any difficulty since it is about the same as welding mild steel with a covered electrode. The only difference is that lower currents are used and the deposit is laid down in small beads with very little puddling. This is done in order to allow the weld to chill as quickly as possible, thus giving a better grain structure.

In welding high carbon steel (above .30 and below .50) the section to be welded must be pre-heated and a pad welded on the parent metal before tying in the sections to be joined. All structures fabricated of this grade of steel should be stress relieved after the completion of the weld.

One of the most important factors in Bethlehem's welding progress, is the clearance of all welding problems through a division of our research department which is headed by a man who has followed welding throughout its various stages of development, and who keeps in touch with the work being done in each plant.

TENTATIVE LIST OF SUBJECTS

FOR DISCUSSION

AT 31st CONVENTION of the

A. I. & S. E. E.

SEPTEMBER 24, 25, 26 WILLIAM PENN HOTEL

PITTSBURGH, PA.

Run Out Table Motors and Generators for Hot Strip Mills .... Employee Representation .... Alternating Current Welding .... Absorption of Products of Wide Strip Mills ..... Non-Metallic-Anti-Friction and Oil Bearings for Roll Necks .... Bright Annealing .... Processing of Flat Rolled Steel .... Improvements in Pouring Molten Steel .... Lubricants for Cold Rolling Steel .... Insulation of Open Hearths.

NEW HOT STRIP MILL AT YOUNGSTOWN SHEET AND TUBE COMPANY GOES INTO OPERATION

Starting construction in June, 1934, the Youngstown Sheet and Tube Company put into operation its new hot strip mill in March of this year. Located at Campbell, Ohio, this new unit, with an estimated annual capacity of 600,000 tons of hot rolled products, covers an area of approximately seven acres.

Some idea of the size and extent of this new project may be gained from the fact that approximately 400 freight cars were needed to transport the mill equipment alone—which weighed over 14,000 tons. Thirty-five thousand cubic yards of concrete were required for the foundation. In length the mill is over a quarter of a mile long. The mill building proper is 84x630 feet and the run-out building is 87x750 feet. In addition, there is a finishing building 80x586 feet, and a motor room 54x440 feet.

In general this new mill is the same as that of some of the other units in this country producing the same product with the exception of a few changes in design and layout thought desirable by the engineers for its successful operation. With rolls 79" wide the mill is capable of producing light plates and skelp from ¼" to ½" in thickness, and hot rolled blue annealed sheets 12 gauge and heavier up to 72" in width. In addition, it will produce hot rolled, and hot rolled annealed sheets in the lighter gauges from No. 13 to No. 18 in somewhat reduced widths.

Adjacent to the mill is a slab yard 55x680 feet, in which slabs ranging from 2000 to 15,500 lbs. in weight are stored ready to be fed into the mill as desired. These slabs are furnished by the No. 2 blooming mill. For heating the slabs to the necessary roiling temperature there are two furnaces 82 feet in length, each of which will accommodate 50 tons an hour. Provisions have been made for a third furnace if necessary.

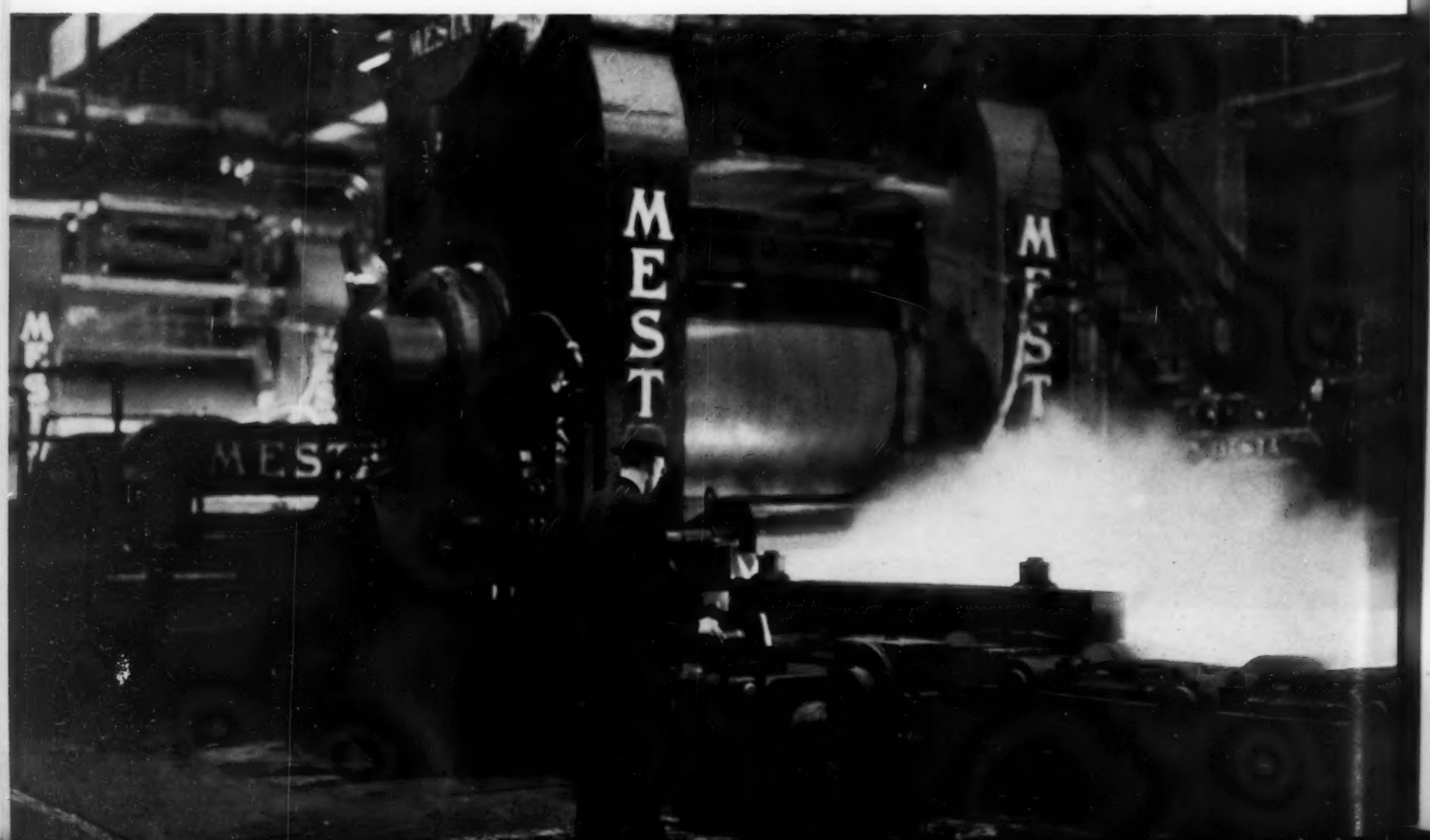
As each cold slab is pushed in at the front end of the furnace, it pushes out a hot slab on the other end. This drops onto a line of rolls and there starts its travel through the continuous mill.

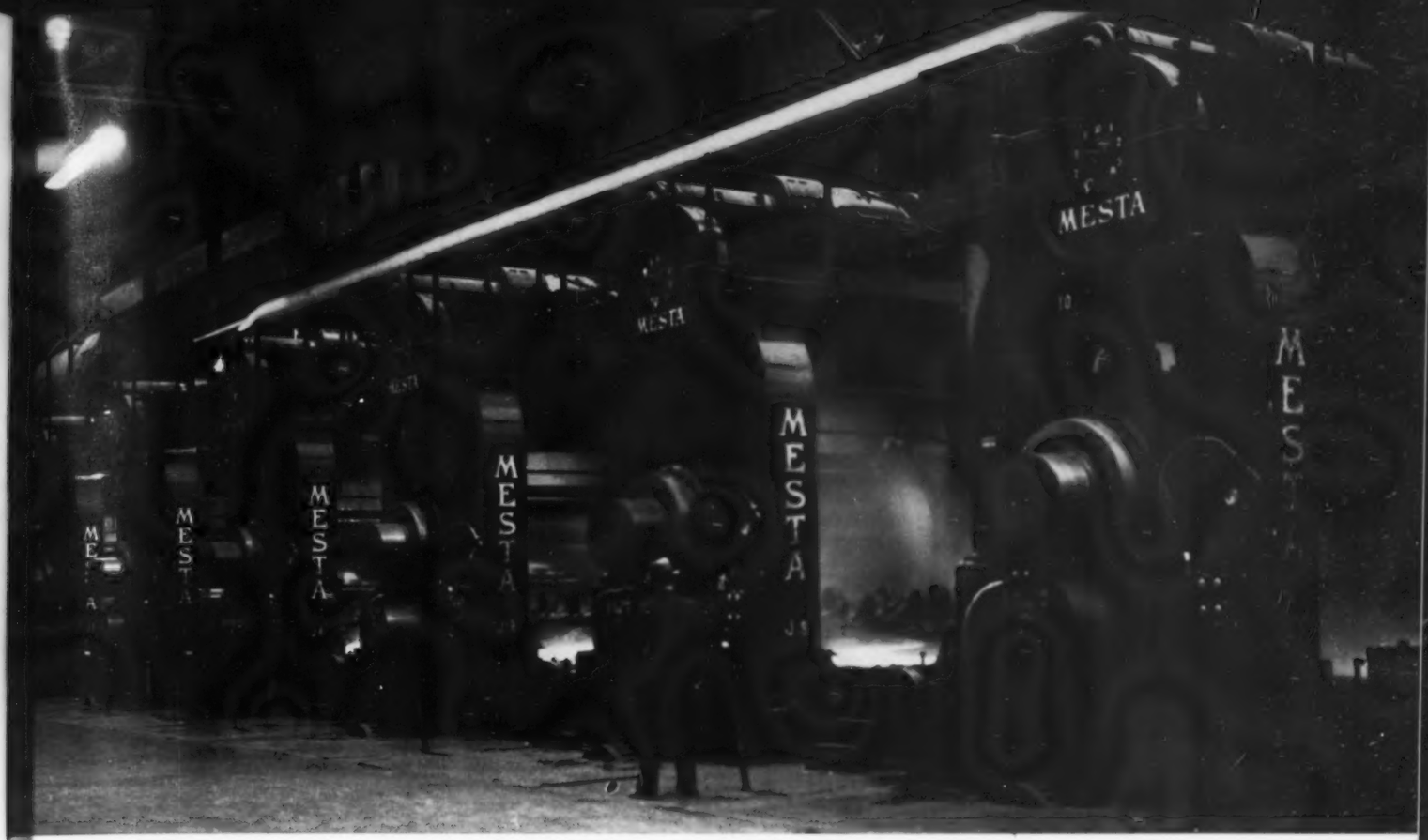
The roughing end consists of a two-high scale breaker, having rolls 24"x79", a four-high spreading stand, having rolls 36" and 49"x96", and three four-high universal stands, having rolls 24" and 49"x79", and with vertical rolls on the entering side.

The finishing end consists of a two-high scale breaker, and six stands of four-high rolls, 24" and 49"x79". The total horsepower of the electric motors necessary to drive both the roughing and finishing ends of this continuous strip mill is 37,500 H.P. Synchronized with the last finishing stand is a hot flying shear which cuts the strip into the desired lengths.

Beyond the flying shear, runout equipment ex-

In this illustration is depicted the roughing end of the new mill.

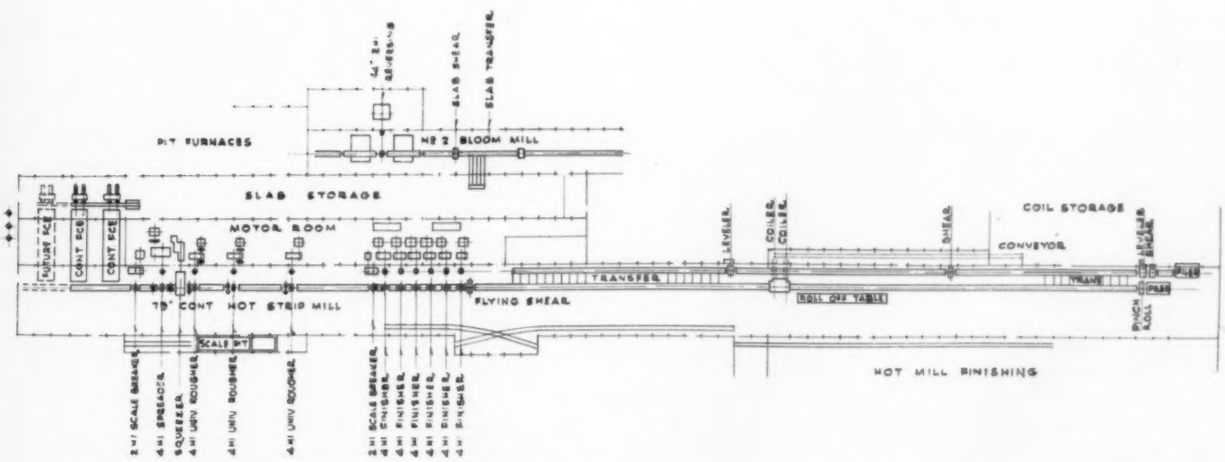




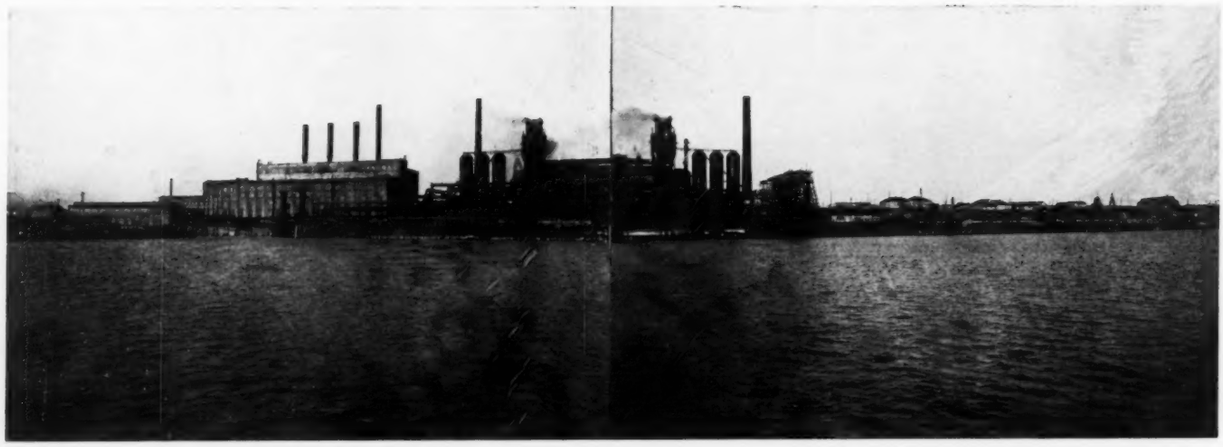
The above illustration shows the finishing stands of the latest hot strip mill going into operation.

tends for an additional 700 feet. This includes tables, hot levelers, transfers, cold flying shears, etc. Coil strip, instead of being cut into lengths, is wound on a coiler and sent to the cold mill for further processing required for special purposes.

Under construction at the present time, and with an estimated annual capacity of from 150,000 to 200,000 tons, the cold mill will be ready for operation some time in June. It will comprise a tandem train of three stands of rolls of 75" face, followed by a reel, two single stands of four-high rolls, one stand of 75" face equipped with a reel for rolling coils, and the other stand of 90" face without a reel for rolling short sheet lengths. Also there will be a single stand of two-high rolls of 54" face equipped with reel for skin rolling coils.



From the December, 1934 issue of the Iron and Steel Engineer, through the courtesy of Stephen Badlam, is presented a plan view of the entire installation.



General view of Azovstal Plant under Construction.

THE TREND OF ELECTRIFICATION IN THE STEEL PLANTS OF THE U. S. S. R.

By P. L. LITVIN, Chief Electr. Engnr.,
Gipromez (State Institute for Designing
Metallurgical Works),
Leningrad, U. S. S. R.
Member, A. I. & S. E. E.

The electrification of steel plants was given little consideration in Russia of the pre-war period. It is true that the capacity and output of the Russian steel plants in those times was low; especially, if we remember, that the output of pig iron in Russia in 1913 was only 4,500,000 tons, whereas in 1934 it was over 10,000,000 tons.

It will be noted that many metallurgical processes in the pre-war period of the Russian steel industry were not mechanised; hand labor being extensively used. But even in the mechanised processes the steam or hydraulic drive prevailed. Thus, the majority of rolling mills operated on steam power; the blast furnace hoists also applied this drive; and for the tilting of the converters in the steel smelting departments the hydraulic drive also prevailed.

Two 930 cu. m. blast furnaces at Azovstal Plant.

The old Russian steel plants in the majority of cases had their own power plants. The generators were driven by steam or gas engines of small capacity, steam turbines being used in a few cases. The voltage generated at power plants did not exceed 500 volts, because the load and distance permitted the transmission of power at such a voltage.

At the time of the great war, and particularly during the years of the civil war that followed, the output of the metallurgical works dropped to a very low figure. The rehabilitation period of the Soviet Steel Industry began only after the end of the civil war, about 1920-1921. Extensive development of the Soviet Steel Industry followed in 1928-1929, when the First Five Year Plan was initiated. The development of the industry is being continued during the period of the Second Five Year Plan.

The development of the Soviet Metallurgy proceeded in two directions: namely, in reconstruction and enlargement of existing plants, and in the construction of new plants. At present a whole series of new plants have been set into operation, as for instance. Magnitogorsky, Kusnetsky, Lipetsky, Azovstal, Zaporogestal Works, etc. The best foreign, particularly American methods were used in the reconstruction of the old plants and construction of new

ones. This was accomplished by employing American specialists in designing, constructing and erecting of new plants, and in the installation of equipment, purchased from American firms.

With reference to the development of the different plants of the steel works we note as follows:

In blast furnace plants the prevailing tendency was to make all the charging arrangements automatic. A blast furnace control was developed, needing only one man for the entire charging operation. In 1930-1931 a design was made of a 930 cu. m. blast furnace, and all new and reconstructed furnaces up to the present time have followed this design. To drive the skip hoist a compound wound motor was adopted. The operation of the bells was accomplished by compressed air, the air valves being electrically operated. The entire blast furnace charging control, including McKee top, stock line recorders and coke charging was so developed that all the operations were entirely automatic. The speed and weight of the skip were coordinated with the entire charging control so as to warrant the furnace production required.

P. L. LITVIN

At present the design of the second standard blast furnace of 1300 cu. m. is being developed. And all the blast furnaces constructed in the near future will follow this design. To control the blast furnace hoists the Ward Leonard control will be applied, because it guarantees a greater flexibility of operation and likewise a possibility of applying a higher charging speed. The bells will be operated by electric hoists in order to eliminate compressed air. There is a tendency also among the Russian engineers to replace the air mud gun by an electrically operated mud gun. The question of introducing remote control of the blast furnace blowers from the blast furnace pulpit is being discussed.

It is interesting to note, that besides these furnaces, using most modern automatic control, there also exist in U. S. S. R. furnaces charged by hand and using horses. These furnaces represent a sort of museum antiquity and very well illustrate the nature of our development.

At the open hearth plants the prevailing type of furnace, used in the production of common grades of steel, are the 150 ton stationary and 250 ton tilting furnaces. Steel of a higher grade is produced in the 80 ton stationary and 100-150 ton tilting furnaces. At plants, producing highest grade steels, the furnace capacity is 30-60 tons. All the auxiliaries of the open hearth plants, including the mixer tilting arrangement and valve reversing gear are throughout electrically operated. At the present moment the question is being considered concerning the adoption of an automatic valve reversing gear and automatic draft control.

A design is being made of an electric drive to replace the hydraulic drive of the basic and acid converters, the only system now being used in our steel plants. This will be installed first at the acid Bessemer plant at the Krivoi Rog Works, in connection with the 30 ton converters, and at the basic Bessemer plant of Azovstal Works, for the 40 ton converters. The air valves on the incoming air mains of the converter will be electrically driven and remotely operated from the same control room, where

250 ton tilting open hearth furnace at Azovstal Plant—the first tilting furnace installed in U. S. S. R.

General view of Magnitogorsk's Power House.

the tilting arrangement is operated. All the moving facilities of the plant, such as hot metal and steel cars are electrically driven and remotely operated from the control pulpit.

Electric furnaces are beginning to be extensively used in U. S. S. R. Steel Industry in the production of high grade steels. At the Zaporogestal Works three phase furnaces are being installed as well as high frequency furnaces; some are already in operation. This plant is located in the vicinity of the powerful Dnieprostroy Hydraulic Power Station, which is furnishing cheap power. Electrical steel production is also contemplated at the Bakal plant, the construction of which will be started in the near future.

In the field of electrifying the rolling mills the Russian engineers were confronted with the utmost difficulties, due to the vast amount of power involved, and owing to the fact that many new manufacturing methods of equipment had to be acquired, including designing and making roller table individual drives with a capacity of a fraction of HP and such large units as the blooming and billet mill motors with their control. The first mills and their electrical equipment were purchased abroad; but after some time the making of such equipment was started at the Russian plants. At the present moment the blooming mill with electrical equipment, being installed in the Zlatoust Works, is entirely of Russian make.

Great difference of opinion among the Russian engineers arose regarding the kind of current to be used in connection with the rolling mill auxiliaries, and in general for all the drives having an intermittent duty and requiring frequent starting. The German steel plants used A.C. for these drives, whereas American plants required the application of D.C. The victory was won by the American methods, as the Russian engineers became convinced, that in severe operating conditions the use of D.C. motors and magnetic control would be fully justified and warrant a high production rate. The development of mill type motors and magnetic control in U. S. S. R. is now based on American Standards.

Large metallurgical works get their power supply from powerful regional stations over high tension lines, extending for hundreds of kilometers. The step-down substation is usually being installed in the vicinity of the rolling mills. In addition to this the metallurgical works have their own power station, located usually near the blast furnace plant. The turbines of steam bleeding type are being installed for the purpose of furnishing the plant and the adjacent workers town with steam. The capacity of the turbo generators is 25,000 kw., each. Their number varies from 2 to 4. The transformer capacity of the plant district substation varies from 10,000 to 30,000 KVA.

AUTOMATIC SHEET MEASURING DEVICE

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Paper presented before the Pittsburgh District Section of the A. I. & S. E. E. November, 1934.

The main application of our automatic sheet measuring device is in measuring the length of sheet or tin plate, as it passes through the mill and thus assisting the operator in setting his screwdown for the next pass, or, informing him whether or not the piece just rolled was of correct length. This device is of particular advantage when used with mills having automatic roller and catcher tables.

The device may be mounted at any convenient place, where the dial is in full view of the roller and is usually on the roller's side of the mill, on that side of the roller table opposite from that occupied by the roller.

The length of the sheet is indicated on a large illuminated dial which has a fixed, as well as, a moving pointer.

In normal operation the fixed pointer on the front of the dial is set in a position which indicates the length of the sheet desired. As long as that length of sheet is desired this fixed pointer does not require moving or resetting. The moving pointer on the illuminated dial begins to move as soon as the pack has traveled far enough to depress the flag switch on the catcher's table. This flag switch may be of any type now used including photo-electric cells. The moving pointer on the dial continues to move until the end of the sheet passes the flag switch when the moving pointer stops moving and stays in its position, thus giving the roller an indication of the length of the piece or pack.

When the table is tilted and reversed, bringing the piece back over the rolls, the indication on the dial stays fixed, thus giving the roller plenty of time to adjust the screw. When the piece again enters the rolls and depresses the flag switch, the pointer does not move until the sheet has passed over it a distance equal to the length shown on the dial. At this moment, the pointer again starts to move and will continue to move until the end of the elongated sheet passes over the flag switch. The dial indication now reads the length of the elongated sheet. This process continues until the pack is finished. Therefore, at any time when the roller looks at the

dial he can see the length of the last sheet or pack that has passed through the rolls.

On the final pass, the sheet does not return over the mill but continues out away from the mill. When the end of the sheet clears the flag switch this dial gives to the roller a clear indication of the length of the finished piece. As the piece moves out, it momentarily depresses a small flag switch on the run-out conveyor or table, which automatically causes the dial pointer to return to the zero position ready to measure the next piece. Other methods of resetting such as push buttons, foot switches, etc., may also be used. It will be noted that the roller never has to do anything to operate this device, as it is completely automatic, and the only thing he has to do is to look at it to find out the length of the last piece that went through the rolls.

As you know, many sheet or tin mill main roll drives are operated either by a steam engine or a wound rotor motor, and for this reason the main roll speed varies with the load in the rolls. On drives of this type, a small synchronous pilot generator is provided, and is geared to the driving mechanism at some convenient location. This location can be remote from the mill, such as in the motor room or any other convenient point. This small synchronous generator supplies power to the driving motor of the measuring device, and as the main roll speed goes down, the speed of the driving motor of the measuring device goes down in proportion, thus automatically correcting and giving an accurate indication regardless of variations in the main roll speeds. On constant speed drives on main rolls, such as those driven by synchronous motors, it is not necessary to supply this pilot generator. The driving motor in the measuring device is operated from a 110 volt, 60 cycle, single phase, A.C. lighting or shop source.

There are many variables in sheet and tin mills due to changes in roll diameters, temperatures of the rolls, etc. Because of the difficulties of correcting for these errors, the dial does not have divisions marked on it, but is calibrated at the beginning of the schedule, according to existing conditions. To accomplish this calibration it is only necessary to run the first piece through in the normal manner. When the correct length is obtained, which can be checked by measuring the first piece, the stationary pointer on the dial is set and the roller is then ready to proceed rolling the schedule. Whenever the moving pointer stops at the position occupied by the stationary pointer, a piece of the same length as the original piece has been rolled.

To operate this measuring device, a very small amount of D.C. current and a very small amount of low voltage A.C. current is required. The A.C. current can be taken from a lighting source or shop source, and if D.C. is not available, the small amount required to operate this device can be handled through a small simple rectifier.

Automatic Sheet Measuring Device.

Many modifications of this device are available for special problems. In spite of the fact that this device was originally designed primarily for sheet mill service, it was found that with some changes, this measuring device was aptly suited to various other applications.

For instance in a beam mill, the operator of the cropping shear must necessarily judge the amount of crop which will result in the maximum number of standard lengths. If this device were mounted near the shear and had two indicating hands, one for units of ten feet and the other in unit feet, the exact length of the beam leaving the mill would be registered and accurate crop cuts could be made resulting in less waste due to faulty crop shearing.

This same type of modification could be used in the rail mill and on various other merchant mill applications for accurate cropping.

Mills rolling sheet bar are also required to crop and cut to accurate lengths. These lengths vary with the size of sheet to be rolled from the bar and such a measuring device would be of considerable advantage.

The above are but a few of the many applications to which this device may be applied, and, no doubt, other uses will occur to you in your daily work.

STEEL MILL APPLICATIONS OF GENERAL PURPOSE MOTORS

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Paper presented before the Pittsburgh District Section of the A. I. & S. E. E. November, 1934.

In presenting this type of discussion, it is a problem to select the most interesting applications and to really do justice to the ones selected. Most of the applications which I shall discuss really are sufficient in themselves for a complete paper. It is also difficult to make a complete story without including the control equipment since the proper consideration and coordination of both the motor and control is necessary for a successful installation on a large majority of applications.

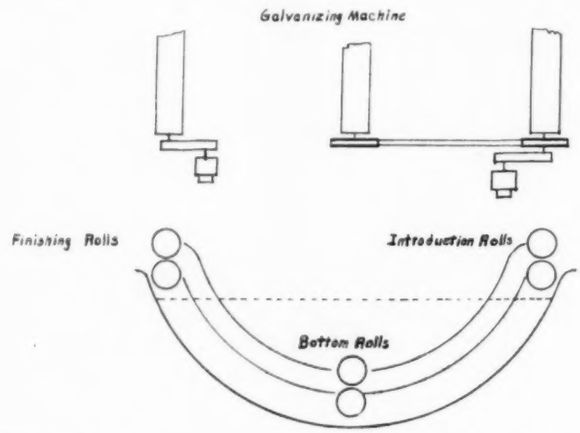

FIG. 1—Schematic arrangement of drive for galvanizing machine.

The first subject of discussion will be the drive for a galvanizing machine. We have recently made several installations of electrical equipment on the machines marketed by the Wean Engineering Company which depart somewhat from the conventional design. This machine consists of a tank with three sets of rolls and guides as indicated in Figure 1 for conveying the sheets through the machine. In the usual design, the three sets of rolls are geared together and driven by a single motor usually an adjustable speed D.C. type.

In practice it is found that the wear on the exit or finishing pair of rolls is much faster than on the pair in the bottom of the tank and the entering rolls. In order to keep the linear speed of the rolls the same it is necessary to either have a set of change gears for the finishing rolls or refinish the other two pair of rolls every time the finishing roll is resurfaced and thus keep all three rolls at the same diameter.

To avoid this situation two motors have been applied to this machine, one driving the finishing pair or rolls and the other driving the entering rolls and the bottom rolls. It is necessary to have these motors maintain the same relative speed to prevent dragging of the sheet on the guides and this is accomplished by the use of shunt wound D.C. adjustable speed motors with a common field rheostat for both motors for adjusting the speed of the sheets through the machine and a vernier rheostat in each motor field to accurately adjust the motor speed to obtain the correct speed relation for the rolls.

One of the factors affecting the thickness of the coating is the speed of the sheets passing through the machine. Therefore in order for it to be suitable for a wide range in thickness of coating a large speed range is necessary. These new machines have been arranged for a 10 to 1 range in speed and this is accomplished by the use of a separate motor generator set, the generator supplying power for the two motors. A 5 to 1 range in speed is obtained by voltage control of the generator and a 2 to 1 range in speed by shunt field control of the motors. If the application is such that the speed range required is less than 4 to 1 the range can be obtained by field adjustment of the motors and the motor generator set can be omitted.

This equipment supplemented by a simple magnetic variable voltage controller represents an application of standard motors and motor generator set which gives a very flexible drive, simplifies the mechanical arrangement of the machine and makes a given machine suitable for a much wider range in product produced.

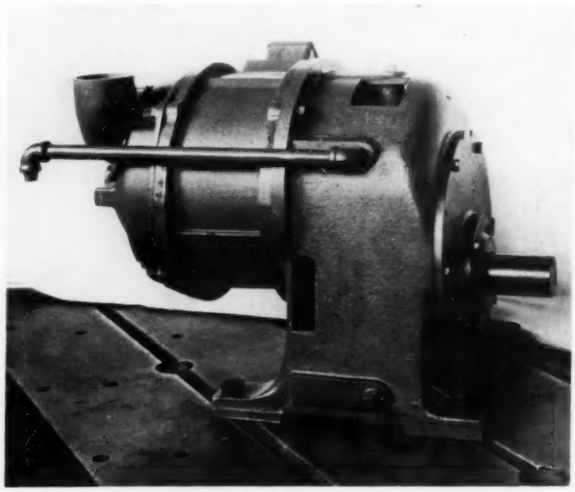

FIG. 2—Gearmotor for runout table drive.

There have been many applications made of individual roll table drives and several interesting discussions have been presented on the subject. I would like however to discuss a few features of motors and gearmotors for this application. The Westinghouse

Company has recently received a single order for 500 of these motors and to the best of our knowledge it is the largest order ever placed for this type of equipment.

Approximately 120 of these units are of the geared type as shown in Figure 2 and represent an ideal arrangement for the particular application. These motors drive the rolls between the last stand of a wide strip mill and the coilers. The gear motor is coupled directly to the rolls and the same housing that supports the rolls support the gearmotor and

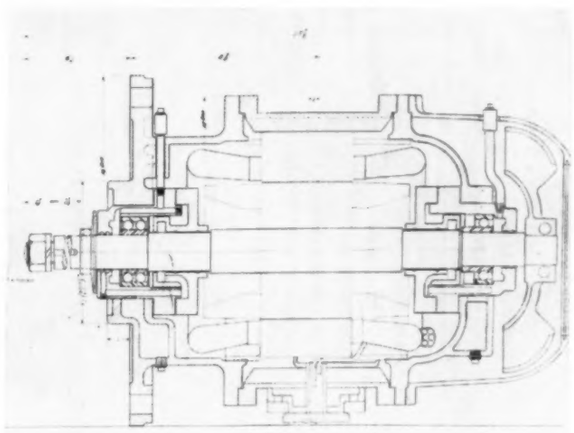

FIG. 3—Flange mounted runout table motor.

makes a complete roll assembly which can be removed as a unit.

The gearmotor is suspended from a top casting and when the mill is rolling plates the rolls are stopped for each piece rolled and the plates transferred to a table parallel to the main table. While the transfer is made the plates lie on the castings that supports the gearmotors and finally become very hot. To keep the heat conducted to the motor to a minimum the feet are mounted on the gear unit and the motor lowered to a point several inches away from the supporting casting.

Even with the gearmotor mounted as described, the ambient temperature is high and the motors are also subjected to a severe duty cycle due to the frequent starting and stopping. To assure a safe operating temperature, the motors are provided with forced ventilation to carry away the heat generated by frequent acceleration and retardation. A special rear bracket has a pipe connection to which the air duct is easily attached. The air circulates through the motor and discharges through suitable openings in the gear housing.

The remaining motors on the various tables are a flange mounted type as shown in Figure No. 3. The motors drive two rolls through suitable gearing built into the table. The motors are of the totally enclosed fan cooled type with Class B insulation. This type is well known but I wish to call your attention to the bearing construction used on these motors.

Even the best insulation has a shortened life if grease is permitted to leak from the bearings into the motor. High ambient temperature and over-greasing make it difficult with the ordinary bearing construction to prevent this condition.

On this roll table motor, the bearing is enclosed in a cartridge. When grease is added with a gun, it enters a chamber in front of the bearing. When this chamber is full, the new grease forces the old out of the bearing into a chamber in the rear of the bearing. A grease seal in the rear of the cartridge makes it practically impossible to force grease out of the cartridge into the motor windings. The excess grease is forced into a by-pass chamber or sump built into the bracket. Any grease getting past the first grease seal will be thrown off the shaft in a relief chamber and eliminates any tendency for the grease to work past the second grease seal into the motor windings.

A grease thrower is provided on the shaft extension to prevent the grease in the gear case entering the motor bearing and should any get past the grease thrower and seal, a relief chamber is also provided on this side of the motor bearing to allow the grease to go into the sump. This prevents any tendency for the lubricant in the gear case to mix with the lubricant in the bearing. This type of bearing has been used not only on roll table motors but on our specially designed roller and catcher table motors and is very successful.

To supply power to the motors a total of 11 variable frequency motor generator sets are used. The general arrangement of this equipment and the necessary control to give the desired flexibility in operation is very interesting and is suggested as a subject for a complete paper after the installation has been completed.

The trend of the continuous method of rolling steel has not only been applied to cold and hot rolling of strip steel but also is being applied to wire drawing. We have recently applied motors and control

FIG. 4—Continuous wire drawing machine—Front View.

equipment to three five-stand wire drawing machines with D.C. adjustable speed motors on each block and the relative speed of each motor automatically controlled by a dancer rheostat. This eliminates any tendency for the wire to slip on the blocks due to incorrect gear ratios or incorrect reductions due to die wear.

We have also applied electrical equipment to a different type of wire drawing machine handling copper wire which I wish to describe in preference to the unit mentioned above since it also includes a

reel which takes the wire from the last stand and winds it onto the reel under tension.

This machine is built by the Vaughn Machinery Company and the generad arrangement of the machine can be seen in Figure 4. It is a five-stand

FIG. 5—Continuous Wire Drawing Machine—Rear View.

tandem machine with the first four blocks rotating about a horizontal axis and driven by a single D.C. adjustable speed motor with a 3 to 1 speed range. The last stand rotates about a vertical axis and is driven by a 4 to 1 speed range adjustable speed D.C. motor. From the last stand the wire is wound onto a reel also driven by an adjustable speed D.C. motor.

The diameter of the empty reel is 12" and the diameter of the full reel wire is 24" so the motor must operate over a 2 to 1 speed range in filling the reel at any given wire speed. Since the wire speed varies over a 4 to 1 speed range the total range of the reel motor is 8 to 1.

Here again it is necessary to resort to the use of a separate motor generator set to obtain the speed range. This motor generator set can be seen in Figure 5 which also gives a better view of the driving motors. The speed of the two main motors is adjusted by means of field rheostats. On the same shaft of the rheostat of the finishing stand motor is a second rheostat connected in the field of the generator and so arranged that the voltage of the generator varies in proportion to the speed of the finishing stand motor. This arrangement automatically changes the speed of the reel motor by voltage control to take care of the variation in speed of the wire. The speed range for the change in diameter of the wire on the reel is adjusted by means of a constant current regulator working on the field of the reel motor which maintains a constant tension on the wire as it is wound onto the reel.

The control equipment is arranged so that the tension is readily adjustable to the tension requirements of the various sizes of wire. The tension remains constant as the diameter of the wire changes on the reel and is also maintained during acceleration so that there are no loose turns on the reel.

When stopping, the finishing stand motor and reel are quickly brought to a stop and retarded at the same rate so that there is no tendency to break the wire.

Time does not permit a detailed description of the control equipment but Figure No. 6 shows the operator's panel where all the control devices are located. On this panel are mounted the rheostats for the two main motors, the tension adjusting rheostat, ammeters for the finishing motor and reel motor and start and stop pushbuttons for the main motor, revolving die motor and motor generator set.

Most tandem wire drawing machines are driven by a single motor and the gear ratio of each block so determined that the die on each block reduces the wire to a standard wire gauge size. However it is sometimes necessary to have special sizes of wire especially in th manufacture of electrical equipment and this results in a change in the percentage of reduction on the last stand. If all the blocks are driven by a single motor it would result in excessive slippage between the wire and the block on the last stand. To avoid this condition the type of machine

FIG. 6—Operators Panel for Continuous Wire Drawing Machine.

shown above can be used since it is possible to independently adjust the speed of the motor driving the last stand.

It is the opinion of some mill operators that this machine can be used to actually draw wire that has a special section.

The addition of the reeling equipment to this unit is especially desirable since it simplifies the problem of future handling in annealing furnaces and other processes. It is also much easier to handle this wire from the feed reel when making a second pass when it is wound tight on a reel compared to a loose coil of wire which frequently snarls especially when drawing wire at high speeds.

If time would permit we could include several additional interesting installations such as the electrical equipment for roll grinders, billet chipping machines, coil handling machines for cold mills, coilers, and flying shears. Undoubtedly some of these installations will be described by other speakers.

J. H. G. McCONECHY

THE GENERATION OF POWER IN INDUSTRY BY DIESEL ENGINES USING HEAVY FUEL OILS

K. E. DeROSAY

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In 1897, after several years of experimental work, Dr. Diesel completed his first successful commercial engine. Since that date there has been a gradual development, resulting from improved methods of manufacturing, discovery of higher grades of materials, scientific design and a deeper knowledge of the fundamental principles of injection and the combustion of fuel oil. Thermal and mechanical efficiencies have increased to such a degree that at the present stage of development a higher efficiency cannot be reached by any other process for converting heat into useful work.

In general the diesel engine develops its power directly from the liquid fuel injected into a cylinder without any previous process. The principal characteristic feature of the diesel engine is the delivery of liquid oil fuel at a pressure of 3,000# to 10,000# per square inch to an injection valve, which delivers a finely atomized spray into a confined volume of air, previously heated to the ignition temperature by the compression of a rising piston. Numerous types of the earlier designs of engines employed various devices, such as hot bulbs or smouldering punk sticks, to increase the temperature of the air to produce the initial stages of combustion of the injected fuel oil. The diesel engine at first became commercially practicable by the use of a blast of air to atomize the fuel, the air being compressed to a higher pressure than the fuel oil and admitted simultaneously with the fuel oil through the same injection nozzle.

In the earlier stages of development, the diesel engine was of the four cycle type; further development produced the two cycle engine, and in both cases atomization of the fuel was produced by the aid of compressed air. The latest phase of this development was the introduction of airless injection for both the two cycle and four cycle types of engines. The most outstanding development in the diesel engine engineering field was the introduction of the opposed piston engine and the double acting engine.

The smaller sizes of engines are of the trunk piston type, and the larger sizes either for stationary or marine use, are usually manufactured with crossheads and guides. The vertical opposed piston engines, which have proved so successful in marine propulsion, are fitted with long piston skirts or trunks on both the upper and lower pistons in addition to crossheads and guides.

There has been much controversy for years over the relative merits of the four-cycle and two-cycle engine. Practically all of the numerous types of diesel engines designed and built for speeds of 1000 R.P.M. and upwards are of the four-cycle design. One of the principle factors for this line of development lies in the simplicity of scavenging and the increased length of time in which the scavenge air can be admitted. Engines of the two-cycle principle in its latest form, where the benefits of uniflow scavenging have been fully developed, and where the latest features in design and construction have been applied to the rest of the engine, can be built from the smallest to the largest sizes to produce complete combustion and operate at higher mean indicated pressures than was hitherto possible with this design.

The addition of these refinements has produced engines with a much higher efficiency, thus obtaining a greater output per unit than can be had with a four-cycle engine and vastly increasing its commercial sphere. A full utilization of the two-cycle principle produces a considerable reduction in weight for a given cylinder dimension.

There is no special difficulty in building a two-cycle diesel engine, running as high as 2500 R.P.M. with a fuel consumption equivalent to that of a four cycle engine, and with a weight reduction which would show a considerable advantage over the four cycle engine. The four-cycle engine, however, still continues to be manufactured, and further interest has been sustained by the adoption of supercharging.

No development has proceeded more rapidly in the past few years than the application of airless-injection of fuel to all types of engines. Four-cycle and two-cycle engines of all sizes, equipped with any one of the various types of injection equipment are in general use, and the more experience gained in actual operation, the more this system becomes established. Opinions are somewhat divided as between the relative merits of multiple pumps versus individual pumps for each cylinder, but in both cases numerous installations demonstrate reliability with complete combustion and low fuel consumption.

The development of the high speed engine is making steady progress. Engines for ordinary industrial purposes are now being made to run at about 600 R.P.M. with the same degree of efficiency and reliability as when produced to operate at speeds at less than half their present ratings.

Power units for rail traction, developing up to 1000 B.H.P., can be produced to run at about 750 R.P.M. and in the sphere of road and rail traction, the smaller engines are operating continuously with reliability and low operating costs at speeds from 1500 to 2000 R.P.M.; all of which greatly enlarges the field of operation for this type of prime mover.

For special applications engines are being developed having a very low specific weight by the application of welded fabricated steel combined with the use of aluminum alloys and high tensile steels for the higher stressed members. For the usual run of commercial applications the fabricated design will not supersede the normal design and construction as rapidly as might be expected, but considerable weight reduction can be effected by a closer study of existing designs and the possible elimination of unnecessary appurtances.

Diesel engines of the future will be produced at a lower cost than now prevailing, and will be used to an increasing extent for road traction, rail traction, marine propulsion, electric generation units and stationary engine work for ordinary industrial purposes.

The problems of vibration and balance have been the subject of considerable research, and with the technical and practical data now available reputable manufacturers can produce and guarantee diesel engines with vibrationless characteristics at the speed designated for their particular applications.

Engines are available today in a sufficient range of sizes and characteristics to meet any industrial requirement from units of approximately 5 H.P. to 50,000 H.P.

The true diesel engine cycle can be classified as follows:

(a) Compression pressure sufficient to raise the temperature to support spontaneous combustion.
(b) Injection of fuel by a blast of compressed air.
(c) A maximum cycle pressure not greatly exceeding the compression pressure.

The modern engine does not follow the above fundamentals of the diesel cycle. Engines developing a peaked card where the maximum initial pressure is in excess of the compression pressure are usually associated with better fuel consumption rates. It should further be noted that the period of combustion is by no means complete at constant pressure and usually continues slowly on the downward stroke of the piston.

In the earlier type of slow speed engine working on the diesel cycle, the combustion volume was designed to produce compression pressures of about 500 pounds per square inch at a temperature of about 950° to 1000° F. In the modern higher speed engine the compression ratios have been increased, producing a higher initial or peak pressure in the cylinder during the combustion period.

Apart from combustion, higher peak pressures seriously affect the mechanical phase producing (a) heavier loads per square inch on the piston pins, crankshaft pins and bearings, (b) higher fuel oil injection pressures, (c) increased wear on the cylinder liners due to increased pressure behind the piston rings, and (d) producing a more massive construction throughout of all the engine parts subjected to the increased load.

In conjunction with fuel injection and compression ratios, the shape of the combustion chamber is of vital importance; a point generally admitted in theory, but seldom appreciated or realized in practice. At the present time the use of a high grade of fuel is generally recommended for continuous and efficient operation of a diesel engine, but a great deal of study and research work is to be expended on the application of a grade of fuel which forms more or less a by-product of the oil companies.

For the smaller installations it seems possible to use certain of the grades of furnace oil, with slight alterations to the combustion spaces and methods of injection. The added advantage of this type of fuel being the elimination of centrifuging or cleaning equipment to remove the non-combustible solids which are found in the heavier grades of fuel. In the larger installations which are usually equipped with independent auxiliary equipment for the handling of circulating water, lubricating oil and the transfer of fuel oil from the storage tanks to the daily service tanks, an oil similar to Bunker "C", equivalent to 16° to 20° Baume, can be used very efficiently when carefully centrifuged.

The diesel industry and the petroleum industry are, of course, mutually interested in the subject of diesel fuels. It is a subject concerning which there is still lacking considerable information of a definite and pertinent nature. There is today no definitely accepted method of accurately measuring diesel fuel quality as regards ignition and burning characteristics, such as we have available in rating gasolines. True, several proposed methods give promise of being satisfactorily developed for this purpose, but it is going to take a large amount of research work and practical testing before a universally accepted standard will be adopted. The usual tests for viscosity, flash, sulphur, carbon content, etc., are naturally well understood and easily determined. It is now recognized by most manufacturers and users of diesels that these physical tests may not be sufficient in themselves to insure satisfactory fuels. Many manufacturers, after listing specifications, qualify them by adding a notation to the effect that actual test in the engines is the final criterion of the suitability of a fuel oil.

There seems to be on the part of many diesel manufacturers a tendency toward expecting oil refiners to produce diesel fuels to close specifications, having all of the desired properties which, from the engine builder's viewpoint, should be incorporated in the ideal diesel fuel. It is possible that the mistake may be repeated of building a mechanism without regard to the most economic fuels available and then expecting the oil industry to tailor-make a fuel to fit the idiosyncrasies of the engine. It is apparent that if this program is followed indefinitely, the cost of diesel fuels is going to be increased and to the point where the inherent economy of diesel engines as prime movers may be seriously interfered with.

The type of fuel oil most widely specified for current design diesels is an uncracked distillate fuel, of low viscosity, with boiling points low enough to insure complete volatilization at relatively low tem-

peratures, and satisfactory minimum amounts of sulphur, moisture and sediment, and carbon content. Further, there is a movement under way to classify such oils on the basis of critical compression ratios, or somewhat as gasolines are rated, by cetene numbers, which may be compared to octane numbers for motor fuels. Such products are available in sufficient quantity to meet present day diesel demands, but were the consumption of such fuels to increase rapidly in the future, the petroleum industry could not supply the demand.

Present day refining methods utilize the cracking process for gasoline manufacture. This is necessary in producing gasolines of high anti-knock value as well as economically imperative in producing sufficient motor fuel to take care of demand without running extensive quantities of crude. Future governmental restrictions on crude withdrawals unquestionably are going to increase the amount of cracking carried on by the refining industry, thus further reducing the quantity of uncracked gas oils available for sale as such.

As the production of cracked gasoline is increased there is a corresponding increase in the amount of residual fuel produced. These materials are, from the standpoint of physical characteristics, ideal for diesel fuel purposes. Their ignition qualities and combustion characteristics are, however, not as satisfactory for the average current design diesel as the uncracked oils. Their value to the refiner, hence their selling price, is, however, very much below that of uncracked distillates and it is evident, therefore, why they are of interest as fuels for diesel engines.

Diesel design can be changed or modified to permit of the engine operating satisfactorily on medium viscosity residual fuels, even when such oils are the by-product of a cracking plant. It is possible that all types of diesels may not be adaptable for such materials; the high speed automotive type diesel, for instance, may require a more highly refined fuel. The industrial type engine operating under less severe conditions of variable speed and changing loads, can, however, be so designed as to operate without difficulty on moderately heavy grades of cracked fuel oil. It may require some little research and practical testing for diesel manufacturers to attain this end, but it is possible, and in view of the availability of cheaper fuel, practically an economic necessity. Automotive diesels can possibly survive using high priced uncracked gas oils since such equipment will compete with gasoline propelled vehicles. The industrial type diesel must, however, compete with equipment using cheaper sources of fuel, such as coal and Bunker "C" fuel, and to hold its advantages over steam plants, must be able to utilize materials as fuel of approximately equal value.

Many progressive diesel manufacturers are already recognizing the necessity of changing or modifying diesel design to permit diesel engines to handle available low priced fuels.

The fleet of diesel tankers operated by the Sun Oil Company and equipped with Sun Doxford opposed piston type diesels, originally used distillate types of fuel. Three years ago a program of burning residual fuels was inaugurated and today these boats are operating on Bunker "C" fuel. To satisfactorily handle this grade of oil preheaters were installed and the fuel is centrifuged to remove all traces of sediment and foreign matter.

The changeover to heavy oil has not increased the maintenance cost on these vessels and their navigability has in no way been interfered with. Some idea of the savings effected can be had by comparing the relative cost today of Bunker "C" and uncracked gas oil—$1.30 and $1.90 per barrel respectively, at eastern seaboard refineries.

The American-South African line has been operating the M/S "City of New York" for over four years. This ship is equipped with two 4-cylinder Sun Doxford diesel engines of 2700 B.H.P. each. The fuel used has been a commercial grade of fuel averaging 200 to 220 seconds viscosity at 100 degrees F., Saybolt Universal. This ship is not using Bunker oil since the fuel tanks are not coiled and no means of preheating the oil is provided. The owners have considered making the necessary additions in equipment to permit handling Bunker fuel and this may be done at some convenient future time.

The reliability of diesel operation on heavy oil as well as the low maintenance cost involved is attested by the record of this vessel. During the first two and one-half years of continuous operation no stops were made at sea and the repair bill was less than $500. After 126,000 miles of engine operation, the maximum cylinder liner wear was .004".

In the early days of oil burning, fuels were principally of the low viscosity type, easy to handle and atomize. As burner equipment was improved and overall design of plants perfected, heavier oil fuels were used and today the most viscous residues, containing sometimes excessive amounts of sediment, water and other impurities, can be handled readily and efficiently. It is understandable that if oil fuels were restricted to the more highly refined fractions, that oil burning could not possibly compete with coal and other solid fuels. So with diesel equipment, designers can overcome the physical and combustion problems of handling and burning heavy oils in internal combustion engines.

Increasing differentials in value between uncracked distillates and cracked residuals will make this economically imperative. The modern diesel, burning the cheaper grades of fuel, will continue to enjoy certain economic and operating advantages over competitive types of prime movers.

For generating electric power, either as the main source of supply or for carrying peak loads, the diesel engine is the ideal prime mover. The smaller units can be made self-contained thereby cutting down the amount of equipment to a minimum and reducing the maintenance and operating charges. When the power is not required it is not necessary to have any auxiliary equipment in operation, as the diesel engine can be started up immediately upon demand from the cold state and shut down again when the service has been completed. During the idle period no operating attention is required, thereby cutting down stand-by charges which cannot be eliminated in the case of steam driven equipment. This particular feature makes the diesel engine a valuable unit in the electric power transmission system in the capacity of carrying peak loads in conjunction with purchased power to eliminate peak demand charges.

In the generation of electric power, the number and size of diesel driven units can be carefully selected to handle the load conditions as they develop.

If the load is more or less constant, then the most economical arrangement would be the installation of multiple units of the same size, the number to include one unit as a stand-by. This arrangement reduces the stand-by investment both in units and spare parts carried in stock to take care of break downs. In the case of widely varying loads the installation of one or two different size units would give the best results. The peak and valley loads can be divided in such a manner that each unit would operate at approximately the rated output at maximum efficiency with a minimum fuel consumption rate.

In the case of installations using existing steam driven generator units or purchased power, where the equipment may be loaded up to a maximum capacity and any additional load cannot be added without the possibility of breaking down the entire system, diesel engine driven generating units of suitable capacity should be installed to run in parallel with the existing transmission lines. These units may be connected into the system to carry part of the base load during peak demand periods, or connected to a separate system to carry the peak loads independently of the main supply.

There are several outstanding diesel engine power plants of large capacities located in different parts of the world. The largest at present in existence is located at Shanghai, China, and consists of eight Sulzer engines totaling 37,500 B.H.P. A two-stroke double acting engine of the Sulzer type, capable of developing 12,500 B.H.P. is now under construction so that the total power of this station will be 50,000 B.H.P. The City of Vernon, California, municipal power plant is the largest diesel station in America, and has a total power of 35,000 B.H.P. made up of five units of 7,000 B.H.P. each. This station is the most complete of this kind, and was put into operation in June, 1933.

The power plant of the Broken Hill Mines of New South Wales, Australia, contains six diesel driven generating units of 2860 B.H.P. each, together with four 1228 B.H.P. diesel engine driven air compressors, making a total capacity of 22,072 B.H.P. The station is designed so that three additional generator units may be installed at a future date.

The Central Electric Station in Copenhagen, Denmark, has a capacity of 145,000 K.W. The interesting feature of this station is the installation of a 22,500 B.H.P. diesel engine connected to a 15,000 K.W. generator for peak load operation, in conjunction with the steam turbo-generators. The station is capable of being extended to contain three additional diesel-generator units with a total output of 60,000 K.W.

The railroad companies have now felt the need of a cheaper form of traction in order to meet the growing competition of other systems of transportation, and the diesel engine has been recognized as a means of meeting this competition. In all countries of the world diesel traction is being taken up as a means of reducing costs. The advantages of the diesel system over steam are manifold. There is a substantial reduction in the cost of fuel, with a corresponding reduction in the cost of maintenance, the availability of the diesel engine is greater, water is only required in small quantities and refueling can be done, not only more expeditiously, but at longer intervals.

The development of the rail car has proceeded quite rapidly, and there are some marked differences in the various designs when the mechanical features are examined. Two systems of transmission are employed, namely, mechanical and electrical. Several large diesel engined locomotives patterned after the conventional steam type have been built for heavy passenger and freight trains and are now in operation in some of the European railway systems. The greatest interest has been centered around the development of a moderately powered diesel shunting locomotive, and tests have proved that this application is satisfactory both from a mechanical and economic viewpoint. The outcome of future railway transportation seems to lie in the development of the high speed, light weight, stream lined diesel engined trains of the type recently completed in this country for the Union Pacific and Burlington Railroads.

In the case of industries occupying large acreage where it is essential to do much transportation between different buildings, the use of diesel engined shunting locomotives represents a very considerable economy compared with ordinary steam locomotives for the same purpose. The diesel engined locomotive is always available for service, and during the non-working periods is shut down completely without the necessity of any stand-by service or maintenance. The engines can be guaranteed to start immediately from cold, even under the worst conditions of low temperature.

Although the diesel engine offers the most efficient means of converting heat into useful work, there still remains approximately two-thirds of the total heat content of the fuel that is wasted through the jacket water and exhaust gases. By the use of waste heat boilers it is possible to recover much heat from the exhaust gases which would otherwise be dissipated into the atmosphere. The temperature of the exhaust varies from 300° F. to 700° F. with each type of engine, and boiler units can be obtained to produce hot water or steam at 15 lb., 50 lb. or 100 lb. working pressure with feed water temperatures of 60° F. to 160° F.

Where the supply of cooling water is abundant the water discharged from the engine cooling system can be used to advantage as boiler feed water. The steam output from waste heat boilers can also be used to operate evaporators which supply pure non-scale forming water for the diesel engine cooling system where the raw water supply is not suitable for such purposes. Not all of this supply of distilled water can be used for the engine cooling system, since the cooling water is re-circulated through heat exchangers and only sufficient for make up is drawn from the pure supply. The steam produced from the waste heat boilers where not required for other process purposes, can be used for heating the fuel oil before it is supplied to the engine and also to heat the lubricating oil before centrifuging. With the installation of waste heat boilers it is possible to recover 60 to 65 per cent of the heat contained in the exhaust gases, reducing the exhaust gas heat loss to less than 15 per cent of the total heat in the fuel.

In addition to heat recovery the waste heat boiler is a very efficient silencer, and in the majority of installations no further muffling equipment is required. With the introduction of supercharging, the exhaust gases can be made to furnish useful power

by the application of an exhaust-gas turbine directly connected to a turbo-blower.

The slow speed engine can be safely guaranteed for a period of over twenty years. The fuel consumption and cost of repairs at the end of this period are about equal to the first year of installation. The actual life of the high speed engines cannot yet be determined as engines of this type have only been in service for a few years. It would, therefore, seem safe to assume 5 per cent for depreciation on both types of engines. When engines are installed in existing power plants the present engine room staff can easily operate the additional units. In the case of all diesel driven unit stations, the operation expenses depend entirely upon whether the plant is operating on a 24 hour per day or a work day basis.

It is practically impossible to estimate the cost per K.W.H. until a very careful study has been made of each proposed installation, and allowances made for such items as plant load and plant service factors, together with the cost of fuel and lubricating oil delivered at the particular site.

The maximum rates per annum for fixed charges on the overall investment may be taken as follows:

Cost of Money	7%
Taxes and Insurance	2%
Depreciation	3.02%

Where the actual operating conditions have been known or predicted, estimates have been made showing that power can be produced at from $.0044 to $.008 per K.W. These figures include a full operating crew with a chief engineer and necessary assistants.

LIGHTNING AND LIGHTNING PROTECTION

By H. E. BUSSEY,
Engineer, Southeastern District, General Electric Co., Atlanta, Ga.

Paper Presented Before the Birmingham District Section of the A. I. & S. E. E., January, 1935.

It is going to be my effort to deal with this subject in a manner that might almost be said to be elementary. The purpose of this is to make the data presented most useful for practical application, by the operation man, to his specific conditions. I do not mean by this that I shall, or can, offer a general prescription which may be applied to any and all conditions, but for the majority of operating conditions it will apply. The subject is a complex one but happily is becoming simplified by the intensive and intelligent research by the manufacturing companies.

I wish to enumerate the points I will endeavor to make. 1st—That the nature of lightning is now well understood. 2nd—That the methods of, and the equipment for, protection of electrical machinery against damage by lightning have been developed, not by hit or miss theories but by methods as precise as those employed in any other engineering development taking into account the variable factors of the conditions to be met.

The Nature of Lightning

Every one is familiar with Benjamin Franklin's famous experiment which proved to his satisfaction that lightning is an electrical disturbance. We must go much further than that to understand for our purposes, the nature and laws governing the behavior of electrical circuits which we use in the transmission of electrical energy, when lightning discharges occur sufficiently close to them to set up abnormal voltages in them.

When a cloud of water molecules or the ordinary rain cloud contains a charge of electricity and is over or near a transmission line, a charge of opposite polarity to that on the cloud builds up on the transmission line due to the electrostatic field of the cloud. For the time being the charge on the transmission line goes nowhere as it is held, or bound, by the influence of the cloud. As soon as the voltage of the charge on the cloud builds up sufficiently a discharge takes place with the familiar lightning stroke and the electrostatic field of the cloud collapses. The charge on the transmission line is no longer bound but now flows in two directions at the speed of light in the form of traveling waves or impulses.

Reaching the open end of a line or the high inductance of a transformer, the traveling waves are by reflection doubled in voltage. It is plain therefore that the laws governing the mechanics of the traveling waves are in many senses the same as the familiar forms of slow moving waves in a rope or water. So much for the nature of lightning as far as we are interested at the moment in its behavior on a transmission line.

Taking up the second point, much of the development of the older forms of lightning protection was made under the handicap of pure, unconfirmed theory. Laboratory equipment fast enought to measure and to photograph, in a sense, these phenomena of such high speeds and short duration was not available nor could impulses of the order of voltage of lightning be produced for experimental purposes in the laboratory and actual records of lightning discharges, definitely showing the voltages to be expected and the duration of such voltages, were unheard of.

Due to the lack of such confirmation of theories of design of lightning protective equipment, it is not surprising that there was some scepticism of the value of such devices.

For a number of years both laboratory equipment and even that which may be taken into the field for producing and studying lightning effects on transmission lines of commercial systems has been in active use. It has always been a source of wonder to me that some of the earlier designs of protective equipment were so near right in theory as they were in view of the lack of test facilities then, which we now have.

When it is borne in mind that the duration of lightning disturbances is of the order of micro-seconds, or millionths of a second, it is immediately seen that a recording instrument must have no time lag.

Such an instrument is the cathode ray oscillograph. The instrument has no moving parts and the only moving thing—if it may be called such—is a narrow beam of cathode rays which make the record on a stationary photographic film.

The cathode ray oscillograph has been the central figure for some years in the investigation of all short time electrical phenomena. With it the exact action of protective equipment has been determined. The action of insulations under impulses of various types has also been checked and a thorough knowledge of the requirements for devices to protect these insulations has been obtained. Lightning generators, capable of ten million volts and wave shapes of almost any characteristics, have played an important role in the development. With these precise instruments some old fallacies have been exploded, one of which is the choke coil which has been shown to be of no value and, under some conditions, a positive danger.

I am dwelling on the foregoing to show that lightning protection is no longer an art but is very closely approaching an exact science.

Now to take up the actual protective equipment and the characteristics it should have.

Obviously, from an economic consideration alone, machine insulation cannot be increased to withstand lightning voltages even if it were physically possible. Protective equipment must therefore be provided which will act as a safety valve and to operate to relieve the system of all voltages a safe precentage below the rupture strength of the machine insulation. The device must be fast. It must have a minimum of time lag, otherwise the insulation may puncture before the device can act, and it must be capable of handling large amounts of energy for a short time. And a very important consideration, it must repeatedly handle such discharges without damage to itself. It must not pass appreciable current from the system voltage. In short, it must act as a safety valve which opens wide for over voltages and closes again when the voltage is restored to normal.

Thanks to the development of a material known as thyrite such characteristics are practically attained. This material is a rugged ceramic product which has a high resistance at low voltage and a low resistance at high voltages. It has no time lag and therefore is almost ideal for application to this problem.

Certain fundamental principles in the application of protective equipment have been evolved by experience and research.

1—The ground to which the arrester is connected should be as low as possible in resistance. We think that no ground should be above 15 ohms A-C measurement and for important stations, the ground resistance of the order of 5 ohms is a maximum. It should be lower.

2—The leads from line to arrester and arrester to ground should be as short and direct as possible.

3—The arrester should be as close as possible to the apparatus it is to protect. A distance of a hundred feet may make the difference of successful and unsuccessful protection. In the case of steep wave fronts, reflections may produce destructive voltages at the terminals of apparatus which will not be relieved until either the insulation has failed or the reflected wave has time to return to the arrester.

4—Probably the best form of ground is the multiple iron pipe ground driven to permanent moisture level and, periodically, thoroughly salted.

5—Arrester ground should be tied to apparatus ground.

The insulation specifications to which practically all electrical apparatus is built are those of the A. I. E. E., which call for a one minute test at 60 cycles of twice the rated voltage plus 1000. Fortunately, oil immersed apparatus—such as transformers, will stand for a short time a considerably higher impulse voltage. The situation is somewhat different with rotating apparatus with dry type insulation. Such insulation does not stand impulse voltages greatly in excess of the 60 cycle one minute breakdown voltage. While the actual 60 cycle failure voltage is always considerably in excess of the test voltage, this test voltage applies only to the major or insulation from winding to ground. There is the further complication of turn to turn insulation in the coils. The space for insulation in such machines is restricted and the turn to turn voltages may be—say, from 1 volt to 400 volts. Insulation that is many times ample for these voltages is not sufficient when steep wave front lightning impulses enter the windings as, under these conditions, the stresses may be increased 100 to 1000 times normal. Since it is not economical or feasible to insulate such coils to withstand such stresses, and because it is feasible to protect insulation normally in use, it appears rational to apply protective measures.

In addition to the piling up of voltage between turns by steep wave fronts, it has been shown by Mr. E. W. Boehne that due to reflections of the waves that high voltages to ground are built up. This latter trouble may be overcome by grounding the neutral of Y connected machines, but where machines are delta connected, or it is not feasible to ground the neutral, the problem becomes more difficult. To meet these conditions it has been shown by Rudge, Wieseman and Lewis that the following are effective measures.

1—For grounded neutral machines, use a 1/10 mf. capacitor between each line and ground at the machine terminals. Install line type arresters 2000 and 500 feet from the machine. At the machine also use a special arrester having a lower flashover value than the standard arrester. Use ground wires over the line for 2000 feet to protect against direct stroke on this section of the line.

2—For ungrounded neutral machines, use the same except use 5/10 mf. capacitors.

The purpose of the line arresters is to insure that a definite voltage crest reaches the capacitors and a definite charging rate of capacitors through the surge impedance of the section of line between the arresters and the capacitors.

The purpose of the capacitors is to slope back the steep wave front so that the turn insulation will not be over stressed and to keep down voltage due to reflection.

I consider the question of protection of rotating apparatus most important regardless of whether directly connected to overhead lines exposed to lightning or with intervening transformers. Steep wave front disturbances may be transmitted through transformers from the high to the low voltage side both by electrostatic as well as magnetic coupling between primary and secondard with the wave shape as to steepness of wave front practically unchanged

with destructive effects to turn insulation and insulation to ground.

As a concrete example of what may be done, a calculation made some time ago showed the following:

The machine in question was a 20,000 kv-a, 11,000 volt synchronous condenser fed by a transformer bank from 110,000 volt lines. The 11,000 volt lines were short and not directly exposed to lightning.

Two assumptions were made; first, a relatively slow wave of 1½ microsecond front and a 40 microsecond tail, and, second, one that is faster—that is, 1 microsecond front and 5 microsecond tail.

With the slow wave a maximum voltage of 40 Kv could appear on the 11,000 volt side of the transformer which, by reflection, would increase to 47 Kv at terminals of the machine. If the faster wave occurred, the maximum would be increased to 67 Kv at the transformer and 80 Kv at the terminals of machine. Obviously the insulation was being overstressed as the crest value of the A. I. E. E. high potential test for 11,000 volt machines is 32.5 Kv. The foregoing relates to voltage stresses to ground. By the proper application of lightning arresters it is possible to reduce the maximum voltage impressed to 26 Kv.

Considering the turn insulation, the estimated maximum allowable voltage per turn was 2.5 Kv. The voltage per turn impressed without the protective capacitors and lightning arresters was from 8 to 12 Kv, or from 3.2 times to 4.8 times the allowable value.

With the correct protective equipment, the calculated value of turn voltage maximum was .7 Kv or a factor of safety of 3.6 or a reduction in stresses to less than 1/10th to 1/17th of the previous values.

ITEMS OF INTEREST

PERSONNEL CHANGES

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A. H. Wardwell, formerly assistant to the vice president, National Tube Company, Pittsburgh, Pa., has been appointed the assistant general superintendent of the McKeesport works. Previous to coming to the city offices of the National Tube Company, Mr. Wardwell had been the superintendent of the blast furnaces of the McKeesport plant.

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H. H. Wood, until recently manager of the rolling mill division of the Timken Roller Bearing Company, beginning May 15, will have charge of the newly opened office of the Morgan Construction Company, Koppers Building, Pittsburgh, Pa.

H. H. WOOD

After graduating from Cornell in 1912 with a degree in mechanical engineering, Mr. Wood was engaged in Public Utility Work in the Middle West for several years. From 1918 to 1925 he was affiliated with the Western Cartridge Company, his work covering engineering and operation. In 1925 he joined the Laclede Steel Company in the capacity of chief engineer. Leaving the Laclede company in 1929, Mr. Wood joined the sales department of the Timken Roller Bearing Company, and in 1934 was made manager of the rolling mill section of the sales department.

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Dr. John Chipman has joined the research staff of The American Rolling Mill Company as Associate Director of the Research Laboratories. He will be responsible for research activities in the field of melting and refining metals. For six years he was research engineer in the Department of Engineering Research at the University of Michigan.

Dr. Chipman was the recipient of the Howe Medal of the American Society for Metals in 1934, being awarded this distinction for his paper on "The Application of Thermodynamics to the Deoxidation of Liquid Steel." He was graduated from Sewanee in 1920 and received his M.S. degree at the University of Iowa in 1922 and his Ph.D. degree at the University of California in 1926. For two years he taught physical chemistry at Illinois Weslyan and for three years taught the same subject at Georgia Tech.

For several months he has been devoting part time to Armco's research laboratories, but will now give all his time to his new responsibilities.

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Superintending the construction of the new hot strip mill of the Bethlehem Steel Company, Lackawanna, N. Y., is C. R. Fox who will also be in charge of its operation. For the past five years the assistant in charge of the blooming mill, bar and 60" hot strip mills of the Wheeling Steel Corporation, Steubenville, O., Mr. Fox had been previously engaged with the National Tube Company, Lorain, O.; Youngstown Sheet and Tube Company, Youngstown, O.; Corrigan-McKinney Steel Company, Cleveland, O., and Weirton Steel Company, Weirton, W. Va.

Three new directors were elected at the annual meeting of the stockholders of the Jones & Laughlin Steel Corporation April 24, one to fill a vacancy, and two to occupy the additional directorships created by action of the stockholders at the meeting. The

F. E. FIEGER

new members of the board are Dwight Clark, William B. Todd and F. E. Fieger.

Mr. Clark is Treasurer of the Phillips Properties, Inc., owned by members of the Laughlin family.

William B. Todd was elected Vice President in charge of sales as well as a director. He has been general manager of sales of the Corporation since 1931. Mr. Todd resigned the vice presidency of the Union Drawn Steel Company in 1922 to go with Jones & Laughlin as manager of the cold finished sales division. In 1930 he was made Assistant General Manager of Sales and the following year General Manager of Sales.

F. E. Fieger, who since 1929 has been General Manager, was made a director, a member of the executive committee, and Vice President in charge of Manufacturing Operations. Mr. Fieger came with Jones & Laughlin in 1917 as superintendent of the Wire Department, Aliquippa Works, and the next year was made superintendent of steel works. He was made assistant superintendent at Aliquippa in 1920; general superintendent of that plant in 1923, assistant general manager of the Corporation in January, 1928 and General Manager in charge of Manufacturing Operations in October, 1929.

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Effective May 1 the Chicago office of the Clark Controller Company, Cleveland, O., will be in charge of T. E. Beasley assisted by D. L. Orton and R. H. Osborne. This change was necessitated by the resignation of R. E. Bock, formerly in charge of the Chicago district, who left the company to affiliate himself with O. M. Bercaw in the sale of electrical equipment in the same territory.

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J. K. B. Hare, central station and transportation sales manager of the central district for the Westinghouse Electric & Mfg. Co., has been appointed the manager of the Buffalo office, succeeding H. F. Boe, who has been named assistant manager of the eastern district in New York.

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To succeed the late J. B. Faulds, superintendent of the mechanical department, Youngstown Sheet and Tube Company, Brier Hill Works, J. D. Williams, formerly the assistant, has been promoted to head this department.

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N. W. Pickering, president of Farrel-Birmingham Company, Inc., Ansonia, Conn., and Buffalo, N. Y., sailed on April 8 for a two months trip which will take him to a number of countries of Europe. The trip is one combining business with vacation and Mr. Pickering will spend some time with the company's representatives in England, France, Sweden and Norway. He also will visit Germany and Italy.

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A. W. Robertson, chairman of the board of the Westinghouse Electric & Manufacturing Company, announced that, at the annual meeting of stockholders of the company held April 10, Winthrop W. Aldrich, H. B. Rust and Samuel M. Vauclain were re-elected members of the board of directors.

The election of John L. Hall, senior member of the law firm, Choate, Hall & Stewart of Boston, as a director of the company was also announced.

Mr. Hall, born in Willimantic, Conn., the son of the late John Manning Hall who was a president of the New York, New Haven & Hartford Railroad, began the practice of law in Massachusetts in 1896, following his graduation from Yale Law School.

He is a director of the Merchants National Bank of Boston, the New York, New Haven and Hartford Railroad, the New York Ontarion and Western Railroad, the New England Steamship Company, the Connecticut Company, the Massachusetts Fire and Marine Insurance Company and vice president of the Boston Herald-Traveler Corporation.

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At a recent meeting of the Electric Hoist Manufacturers' Association, Carl O. Hedner of The Yale & Towne Manufacturing Company, Philadelphia division, was elected to the office of chairman.

Mr. Hedner joined the Yale & Towne organization in 1923 and was appointed district manager of the Southeastern territory selling materials handling equipment to industry. He directed sales in his assigned territory with notable results and later was brought into the home office as manager of sales of chain hoists and allied overhead hoisting and conveying equipment, a position which he still holds.

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Ralph A. Terrell has recently joined the Ingersoll Steel & Disc Co. Division of Borg-Warner Corporation, at their West Pullman (Chicago) Plant as their chief engineer, succeeding S. S. Battles, resigned, to become president of the Midwest Stamping and Enameling Co., Morrison, Ill.

Mr. Terrell, a graduate of Cincinnati University, was formerly superintendent and chief engineer of the South Bend Tool and Die Co., South Bend, Ind., and previous to that efficiency engineer for the Frigidaire Corporation, Dayton, O.

It has been announced by the National Tube Company, Lorain, Ohio, that W. C. Chancellor, formerly Superintendent of the Metallurgical Department, has been appointed the assistant general superintendent of that plant succeeding J. L. Mauthe who has resigned to accept the position of assistant district manager of the Youngstown Sheet and Tube Company, Youngstown, Ohio.

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Worthington Pump and Machinery Corporation announces the appointment of J. E. Holveck as special sales engineer, operating from its Pittsburgh Office, but extending his activities also to the territories of the Cleveland, Detroit, Chicago and Buffalo Offices.

J. E. HOLVECK

Mr. Holveck was formerly a member of the engineering staff of Worthington's Holyoke Works and later was associated with The Aldrich Pump Company, as sales engineer in its Pittsburgh and Middle West districts.

He has been responsible for many developments in pumping equipment and hydraulic accessories, principally associated with high pressure applications. These have been utilized mainly in industries requiring hydraulic power as a medium of production in steel, other metals, and plastic materials, and includes also high pressure boiler feeding and oil industry applications.

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The Harnischfeger Corporation of Milwaukee announces the appointment of E. Kapke as assistant sales manager of its crane division.

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G. N. Harris and J. G. Green, formerly of the Westinghouse Electric and Manufacturing Company, and Henry Harris, formerly president of the United Electric Light Company of Wilmerding, Pa., have formed a corporation, the Harris-Green Company, with headquarters in the Farmers Bank Building. The items which they will sell are motors, control, transformers, line material, power factor corrective devices, and other similar materials, used by public utilities, industrial plants and commercial establishments.

A. J. O'Leary has been appointed assistant to general manager of sales at Lukens Steel Company, Coatesville, Pa. Prior to joining the Lukens organization in 1916, he was with the Pennsylvania Railroad and Alan Wood Steel Company.

Mr. O'Leary spent five years in the mills and mill service departments at Lukens before he was transferred to the sales department, where he served since 1931 until his recent appointment as assistant to general manager of sales.

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C. J. Thomas, formerly executive secretary of the Greater Buffalo Advertising Club, has been appointed secretary-manager of the Cleveland Engineering Society.

WITH THE MANUFACTURERS

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With Edmund Lang, president, acting as host, the Crocker Wheeler Electric Manufacturing Company, Ampere, N. J., conducted an "At Home" party on May 10 and 11. This was held for the purpose of displaying the company's many products among which was an 8000 horsepower induction motor.

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The Allis-Chalmers Manufacturing Company, Milwaukee, Wis., announce the availability of a leaflet No. 2100 entitled "Wound Rotor Induction Motors," also leaflet No. 2183 on "Type E Direct Current Motors and Generators."

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A new alloy steel has just been announced by the Youngstown Sheet and Tube Company. This new product known as Yoloy is a nickel copper alloy steel, having an exceptional resistance to corrosion, high tensile strength combined with high ductility, workability and weldability. Yoloy steel is produced in sheets, strips, plates, bars, shapes, wire and seamless pipe.

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A new, small, low priced motor generator type of arc welding machine is announced by The Lincoln Electric Company. This machine brings the many advantages of arc welding to automobile repair shops, sheet metal and fabricating shops and others called upon to weld thin gauge materials.

Known as the SA-100, this new unit opens up an entirely new field of application for arc welding, since it delivers as low as 30 amperes at the arc without use of auxiliary devices.

The new SA-100 is of motor driven type, with a current range of 30 to 125 amperes. The generator is of single operator variable voltage type with 100 ampere NEMA rating. Easy welding is assured by patented dual control which provides independent adjustment of open circuit voltage and welding current.

The motor installed is the Lincoln "Linc-Weld" 5 horsepower squirrel cage induction type for across the line starting. The starter switch is of push button type. Wing nut cable terminals permit easy change of welding current polarity. The new welder is normally 220 or 440 volts and can be furnished for 110 or 550 volts, 3 or 2 phase, 60 and 50 cycles

ADVERTISING PAGES REMOVED

as desired. Connections are readily available for reconnecting from 220 to 440 volts, or vice versa.

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The Ferro Enamel Corporation, Cleveland, Ohio, have applied alternating current to the pickle bath with very marked improvements in pickling. An additional agent consisting of an organic acid is added to the sulphuric or other inorganic acid generally used. A proper coordination of electric current and the organic inorganic bath solution results in an increased pickling speed, reduced total acid costs and excellent finish for the pickled work. The pickling time can be cut in half.

The process which is patented was originally developed for improving the finish on enamelers iron but has shown so many advantages that the scope of its application has been extended to the pickling of practically all forms of steel. The growing list of successful installations now includes mill installations for pickling tubes, sheets, strip steel either batch or continuous, forgings, bearing shells for automobiles and drawn bars.

An installation consists of a low voltage transformer with its secondary of generally 12 volts connected to the pickle bath by submerged graphite electrodes. No direct contact with the work is required. The operation is the same as in the previous pickling practice except faster. The operator can determine from his bath current ammeter readings when acid is needed and how much.

The process is known as the Ferrolite Pickling System and information on it can be obtained from the factory or from the J. H. Overpeck Co. in the Pittsburgh District.

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The U. S. Bureau of Reclamation has awarded a contract to Bailey Meter Company covering turbine flow meters for the initial installation of four 115,000 horsepower hydraulic turbines at Boulder Power Plant, Boulder Canyon Project. These Bailey Fluid Meters which will be installed on the world's largest hydraulic turbines will measure water supplied through 13 ft. diameter penstocks under an average net head of about 530 feet.

The meters are of the type which will indicate and record water flow in terms of cubic feet per second and will continuously integrate in millions of cubic feet. Each meter will be designed for a maximum differential pressure of approximately 120" of water and will be connected to Winter-Kennedy pressure connections in the turbine scroll casing.

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Delta-Star Electric Company, Chicago, Ill., announce a new disconnecting switch known as type "RFB-2C" Disconnect for lightly loaded 7.5 and 15 K.V. circuits—hook-operated disconnect for use on rural or lightly loaded circuits which do not require ratings in excess of 400 amperes where economy must be given first consideration but not to the extent of impairing service. Embodies non-ferrous parts on "hot" side, self-aligning contacts, safety latches and solderless lugs.

The formed steel universal base was developed for use where the cross arm spacing in double arm construction is approximately the same as the switch insulator spacing.

The insulator units are mounted on one flange, the mounting holes are on the other. This permits easy replacement of insulators as there is no interference between the cross arms and insulator bolts.

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New improvements in materials handling have come in such rapid succession during the past two years, that on many occasions they literally have stepped upon one another's heels.

With some manufacturers, the mere keeping abreast of customers' incessant demands has brought about the continued replacement of even very recent developments with still newer and more efficient equipment. These conditions have added to the difficulty of keeping the story up-to-date.

But one manufacturer, at least, has not only "taken time out" to assemble and classify the facts, but has found a way to present them clearly and vividly to busy executives. In a recent booklet entitled "This New Industrial Pick-Up," The Elwell-Parker Electric Company of Cleveland has managed to clothe a rather heavy technical discussion with enough refreshing interest to encourage reading throughout, while supplying vital and needed information on each page.

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The Trumbull Electric Manufacturing Company, Plainville, Conn., announce a new line of small Tumbler Type Motor Starters, both single and double pole. These starters provide protection for small motors up to 1 H.P., 230 V. A.C. by heater units which are interchangeable, the ampere rating of the heater being indicated on the front of the switch base.

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To simplify the machining problems developed by the increasing use of manganese steel in crane and hoist sheaves, and to insure accuracy of mounting with its attendant long life and ease of operation, The Timken Roller Bearing Company has developed a new type of bearing mounting using Timken double cup bearings. This new type of mounting permits the sheave hub to be bored straight through at a single setting.

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Included in an order amounting to more than $1,250,000 for new electric equipment to be furnished and completely installed by the General Electric Company at the Lackawanna plant of the Bethlehem Steel Company, are seven D.C. motors totaling 22,500 horsepower for driving the finishing end of Bethlehem's new continuous hot strip mill—one of the world's largest. This finishing end drive will consist of two 4500 H.P. and three 3500 H.P. motors, and one each of 2500 H.P. and 500 H.P. ratings.

In addition, the order includes two 3-unit, 6000-Kw. motor-generator sets to supply power for the above motors; one 3-unit, 6000-kw. motor-generator set to supply power to the drives of two tandem cold strip mills; the most modern ventilating system yet used in a steel mill motor room; and complete switchgear and control equipment for the preceding apparatus, including 19 metal-clad oil circuit breakers each with an interrupting capacity of one-half million kilovolt-amperes.